uncomplexed signal particles and to move the binding complexes to a fluidic zone where it can be detected by the detection element. The device may further comprise servo-mechanical components and mechanisms to control the locations and movements of the detection element, the magnetic microcoil array, and optionally, a flow controller.

[0020] The embodiments of the invention also relate to methods of detecting the presence of an analyte in a sample using the device and to methods of making the device. The detection element of the embodiments of the invention may be part of an integrated device that also serves as a microarray or macroarray, containing an integrated circuitry component, or a microfluidic device, a MEMS, or a combination thereof. Therefore, samples contained or processed by the device may be also analyzed by the detection element and/or the detection signals processed for analysis. If necessary, the signals determined by the detection element may be transmitted to another device for further analysis.

[0021] The embodiments of the invention relate to a device and method to transport particle complexes from one solution zone to another of a self-contained fluidic device without active liquid movement. It also allows for effective reactions along the fluidic channel network involving concentrating, dispersing and transporting particles of micro or nano dimensions. The device comprises the following major components: a) electromagnetic array, b) a set of vibrational elements, and c) a circuitry for electronic control and regulation of the magnetic array, the vibrational elements and data collection elements.

[0022] The embodiments of the invention address the problem of molecular or particulate transport in one fluidic zone to another in a fluidic system without active fluidic movement or using fluid as the transport carrier. Presently the problem described above is solved by method in which molecules are physically separated from one solution phase before being placed in another solution phase; or the molecules are immobilized on solid surfaces and a new solution is introduced involving active fluidic movement. The technical advantage of the embodiments of the invention is that it allows molecular or particulate transport in one fluidic zone to another in a fluidic system without active fluidic movement or using fluid as the molecular transport carrier, which avoids mechanical structures to generate hydraulic pressure or flow, enabling simple and reliable biomedical diagnostic devices. The mixing of reagents from one region with those of another due to diffusion can be reduced by geometric considerations to the level where no mechanical valves are needed to avoid unwanted diffusional mixing, or the hydrophilic reagent solution "droplets" are physically suspended in hydrophobic liquid such as silicone oils through hydrophobic-hydrophilic interactions.

[0023] The embodiments of the invention relate to a device for particle complex transport and detection comprising (1) an array of electromagnetic coils wherein the coil has a magnetizable or high magnetic permeability metal core, and the current for the coil can be controlled and varied in time individually, as well as reversed, to generate a specific magnetic flux distribution and gradient; there can be a magnetizable or high magnetic permeability coupling shape at the end of each coil whose geometry is such to create an optimal magnetic flux, intensity and gradient, in the region of interest; and the device is functionally coupled to a fluidic device to concentrate, disperse and transport particle complexes; (2) A detection system, of optical or electrical nature; for optical: an optical detection system consisting of a lens system and photo-diode, phototube or CCD sensing element, optionally, an optical illumination system consisting of a photo-diode, LED (light emitting diodes), laser or lamp, and a spectroscopy system which could contain diachronic mirror or lens; for electrical detection, the methods can be FET detection, capacitor detection, current and voltage detection; and (3) a central processing unit (CPU) functionally coupled to the array and data/signal collection elements (optical or electrical). The device of the embodiments of the invention could optionally have the following elements: (1) A set of magnetizable material shapes which are free to be moved by the magnetic field generated by the electromagnets and thereby alter the magnetic field. For example, a set of magnetic high mu metal or permanent magnetic objects that can be moved by powering electromagnets. The movement and placement of these objects will change the field enhancing and depleting it where needed. These magnetic shapes can be part of the array (coil cores), around the array (between array and fluidic device) or part of the fluidic device. (2) A set of vibrational elements, functionally coupled to a fluidic device to disperse particle complexes, preferably, being electro-piezo vibration, or ultrasounds, wherein one or more vibrational elements could be addressable individually. (3) A set of temperature controlling elements. For example, a set of element that can change the temperature of the fluidic device. Heating by inductively driving current in coils the fluidic device using the inductor array or electronic peltier devices. (4) A programmable system that can control the electromagnetic array in a set time sequence as well as vary the sequence depending on input from sensing elements. Controlling the vibrational or mixing elements, the temperature controlling elements and optical elements. Monitoring particle complexes within the fluidic device magnetically and optically. (5) A system to move the alignment of the fluidic device relative to the magnetic array and optical and vibrational or mixing elements.

[0024] As used in the specification and claims, the singular forms "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "an array" may include a plurality of arrays unless the context clearly dictates otherwise.

[0025] As used herein, "magnetic particle" refers to a paramagnetic or superparamagnetic particle having any shape, e.g. it can have the form of a sphere, a cylinder, a cube, an oval etc., or may have a variable shape. Different types of magnetic particles which can be used with the present invention are described, for example, by Urs Hafeli et al. in "Scientific and Clinical Applications of Magnetic Carriers", Plenum Press, New York, 1597, ISBN 0-306-45687-7. In one embodiment the magnetic particle comprises a streptavidin-coated magnetic bead. The magnetic particles can be quite small, having at least one dimension ranging between 0.1 nm and 10,000 nm, preferably between 3 nm and 500 nm, and more preferably between 10 nm and 300 nm. The magnetic particles can acquire a magnetic moment due to an applied magnetic field (e.g., they can be paramagnetic) or they can have a permanent magnetic moment. The magnetic particles can be a composite, e.g., consist of one or more small magnetic particles inside or attached to a non-magnetic material, or a hetero/hybrid nanostructures, such as dumbbell-shaped magnetic gold nanoparticles, which are composed by one half of magnetic particle and another half of gold nanoparticle. As such, the term "magnetic particle" encompasses magnetic affinity complexes, coded magnetic affinity complexes, hybrid mag-